

of his earliest studies he returns as to a first love. On the soul-theories of savages and the corresponding eschatology he writes convincingly. The plurality of souls in pulse and blood and breath and shadow, the gradual elimination of some of these and the syncretism of the rest, the place of the dream image in the evolution of the cult of *manes* and in the selection of totems, the literal and unsymbolic character of the latter, the order in which the heavenly bodies enter into primitive worship—these are the points on which Dr. Schultze compresses year-long work into moments of insight and selective description. Believing, as he does, that Germany has a colonial future in direct contact with primitive stocks, Dr. Schultze offers his essay to the understanding of the savage as a help forward to the achievement of the educational mission of his country. A pious gift. H. W. B.

The Study of Bird-Life. By W. P. Pycraft. Pp. 240. Illustrated. (London: George Newnes, Ltd. 1900.)

THIS little volume belongs to "The Library of Useful Stories," now in course of issue by the publishers; and although it must have been difficult to compress a general review of the leading facts of bird-life into such a small compass, the author may be congratulated on the success of his attempt. As Mr. Pycraft is a morphologist rather than a systematist, it would naturally be expected that he would incline rather to the morphological and phylogenetic aspects of his subject, and this we find to be the case. We have, for example, an excellent chapter on the morphology of the bird's wing, while two others treat of avian pedigree, and a third is devoted to the distribution of birds in space and time. Perhaps the most specially interesting chapter in the volume is the one dealing with the flightless birds and their fate, since this is a subject on which the author is peculiarly qualified to speak with authority.

Although, of necessity, written from a purely popular standpoint, the volume contains many passages which are well worth the attention of the scientific ornithologist. If there be a fault, it is the introduction of irrelevant matter, the place of which might have been better occupied by details pertaining to the subject in hand. And if a second edition be called for, the author will perhaps be inclined to modify the statement in the tenth chapter, that "the kind of rock" in which bird-remains are found is sufficient to give a notion "of the bird-life of that particular period of the earth's history." R. L.

An Introduction to the Differential and Integral Calculus and Differential Equations. By F. G. Taylor, M.A., B.Sc. Pp. xxiv + 568. (London: Longmans, Green and Co., 1899.)

THE appearance of still another treatise of this kind shows how earnest and how prevalent is the desire to introduce students of physics to a knowledge of the calculus at as early a stage in their career as possible.

The author has studied simplicity of treatment, but has evidently striven to secure accuracy as well as clearness and distinctness in his exposition of the principles of the subject. A special feature, which will be of great advantage to the ordinary student, is the detailed discussion of numerous examples.

Interspersed throughout the several chapters the student will also find an abundance of not too-difficult exercises carefully graduated and with answers appended.

A fair and not excessive amount of space is devoted to the subject of curves, and the illustrative diagrams are distinctly drawn.

The section on the integral calculus concludes with applications to volumes and surfaces of revolution, centroids, and moments of inertia.

The last section of the book forms a good introduction to the methods of dealing with ordinary differential equations of the first and second orders.

ENGLAND'S NEGLECT OF SCIENCE.

JUST before the first movement organised by Lord Roberts there was probably not one thinking person in England who was not ready to vote for an immediate change in all sorts of English methods of doing things. Consequently everybody was willing to listen to the advice of men who had for years been crying in the wilderness and prophesying disaster. Now, however, that we have worried through our military trouble, we shall probably feel so much ashamed of our intense fright as to put aside most of our desire for reform, and even to have less thought of it than before the war began. It is, therefore, the duty of those who have earned the right to a hearing to prevent the nation from sinking down into its sleepy acquiescence with old methods of working; and I am glad to see that Sir Norman Lockyer, in his speech at the Royal Academy dinner, referred to scientific education as a great, necessary line of defence of our country, secondary only to that of our naval and military forces. Again, two articles have appeared in the *Kölnische Zeitung* (March 10 and 11), which criticise our manufacturing and business and military want of method with an un-sparing pen. The German writer and many English writers seem to think that we ought to copy Germany. Nobody can feel more than I do the great necessity which exists for reform; but I think that our reform must be far more thorough than anything which can be regarded as a mere copying of Germany; the methods which we adopt must be English methods, invented by Englishmen for Englishmen. If our methods are to help to lead in the future to a history comparable in glory with the history of the past, there must be a great common-sense reform in education in England from top to toe. My friends, Profs. Ayrton and Armstrong, and I have so often pointed out the deficiencies of England in matters which we have carefully studied here and in foreign countries, that I hardly know whether an idea on this subject is my own or one of theirs; I do know, however, that we preach often on this subject, and that we never seem to be much attended to.

One thing that seems to be quite exasperating is that almost all the most important, the most brilliant, the most expensively educated people in England; our poets and novelists; our legislators and lawyers; our soldiers and sailors; our great manufacturers and merchants; our clergymen and schoolmasters, are quite ignorant of physical science; and it may almost be said that in spite of these clever ignorant men, and men like them in other countries, through the agency of a few men who are not ignorant, all the conditions of civilisation are being completely transformed. I do not merely mean here ignorance of the principles of science, I mean also ignorance of all those methods of working which come from experimental and observational scientific training. The great men go occasionally to popular scientific lectures (as they go to the Royal Academy), and they think that they comprehend something of the latest scientific discoveries because they have seen some fireworks and lantern slides; they are genial to scientific men when they meet them at dinner parties; but, in truth, scientific men are as much outside their counsels as sculptors or painters, or musicians or ballet-dancers. Among these great men a few visits to Albemarle Street are sufficient to create a reputation for science. I wish to show that this ignorance of our great men tends to create ignorance in our future leaders; is hurtful to the strength of the nation now, and retards our development in all ways.

These great men really direct the building of ships of war, and the creation of munitions of war; that is, they select the men who have to do these things, and they also lay down the unscientific rules which prevent their selected men from doing their work scientifically.

I will give an example. They order that the building

of five line-of-battle ships shall be started immediately. The scientific constructor knows that he ought to throw away—waste—100,000% in making experiments to find out how the older type of ship may be greatly improved. But his superiors have made the rule that for money expended there must be something to look at. Hence no experiments may be made, and the constructor starts at once to expend five millions of pounds on building ships which are nothing like so good as they might be made.

Other examples. For many years huge guns were built of tubes. It was known to the few scientific men who can calculate about such things—the men who are never consulted—that it was not possible to turn and bore those tubes with the accuracy required by the theory. It happens that nature applies a correction to a wrong method of manufacture, and so these guns are not useless. It is quite well known that a little science and expensive experiment would cause the present wire method of manufacture of guns to be discarded for a simpler, quicker, better, cheaper system. The water-tube boilers, so numerous in our Navy, have proved as worthless as the best scientific men thought them from the beginning, and possibly now it is absurdly assumed that all water-tube boilers are useless. The construction of efficient submarine boats was possible thirty years ago. Many electrical and mechanical engineering appliances that might be very useful to an army or navy have never yet been tried under the direction of competent engineers. Above all—and this includes everything—men of scientific training are not chosen for the Government, civil, and naval and military posts where such training is necessary.

If our leaders were merely unscientific—if they were merely like Boers, and had no scientific knowledge—it would not be so bad, for they would probably appoint scientific men to posts in which a knowledge of physical science is needed, and they might accept the opinions of scientific experts. Even if they were like savage chiefs there would possibly be equal chances among all candidates for posts; but, unfortunately, it is as if our leaders possessed great *negative* knowledge of natural science, and as if a man's chances of being appointed to a scientific post, or of having his advice listened to, were in inverse proportion to his scientific qualifications.

Scientific men look around them and see that everything is wrong in the present arrangements, but they also see that it is useless to give advice which cannot be understood by our rulers. And, indeed, I may say that when by accident a scientific man is appointed on a committee, there is a negative inducement for him to do anything.

Many men enter the services by examination. In some cases the examination is supposed to be in science. In truth, the scientific habit of thought, the real study of science, the very fitness of a boy for entrance to the service, would unfit him for passing these abominable unscientific examinations. For some posts—the Royal Artillery and Engineer services, for example—further scientific food is provided by the Government after a man enters. If one wishes to hear how evil this system of pretended education is, let him ask the opinion of some of the professors who are condemned to help in carrying it out. The whole system is foolishness from bottom to top, and the men prepared by the system cannot see how abominable it is even when they are afterwards trying to improve it.

But however harmful the present state of things may be for the Government services, I think that it is much more pernicious for the country at large. We see that the greatest intellects of our time have been developed through an education other than scientific; and as nobody can commend it for the mere knowledge given at school, it is commended for its importance in mental training.

It has been so often asserted by parrots, that many people do really believe that only mere mental training need be given until a boy is sixteen years of age. When one hears such a statement for the hundredth or thousandth time, he sometimes wonders if anybody ever does think for himself. Why, the early period of a boy's life is the time when he is not only getting mental training, but also collecting the largest part of all the knowledge that he ever will possess of the world into which he has come. So great is this stock of facts and theory, that when he looks back upon his life in old age he can hardly find that he has added much to it in the intervening years. Is he a musician in after life? then he certainly learnt his skill, acquired his touch, trained his ear, and learnt thousands of airs in early youth. Is he a poet? it is to his earliest efforts that he looks back most fondly, and it was in his early youth that he learnt off by heart all the poetry that he really knows well in after life. He learns to read and write and cypher with ease and readiness; is this mere training of the mind? This craze for mind-training is really the worst thing that has happened to the hurt of children. It does not seem to be known to the mind-trainer that a child's mind grows most healthily when let alone—when the child is picking up knowledge in his own way. Give a boy a chance of seeing things for himself, and direct him as little as possible. Is there any kind of knowledge likely to be needed by him in after life? let him, when quite young, have some chance of picking up something of it for himself. He learns about people; he cannot help it, as he lives among people.

I take it that whatever kind of knowledge the race has been in the habit of picking up in youth is more easily picked up than any other by a boy himself. A boy takes to thinking for himself so naturally that the greater parts of some vile systems of education seem to be the destruction of this habit. Yes, education often means merely training a boy out of the way he *would* go into the way that we poor creatures think that he *should* go. And hence it is that the boy whose education is neglected, but who has chances of seeing things for himself, has often a much better chance in life than the well-trained prig.

Now there is a kind of knowledge greatly needed in life, that knowledge which is enabling us to fight with and use the powers of nature as they never were fought with or used before our time. The race is not accustomed to picking up this kind of knowledge, and so there is this one case in which artificial help to the child is absolutely necessary. Natural phenomena are complex; let him have a chance of using apparatus that will simplify these phenomena for him. It seems to me that natural science is almost the only study in which instruction from a father or teacher will not obstruct a boy's own natural method of study. And see how many ways of study are offered by it to a boy. Some of the sciences are greatly observational. If he is fond of abstract reasoning, he attacks things from the mathematical side. If he is fond of fireworks, he can attend popular lectures. If he loves to make and fiddle with apparatus, and use it quantitatively, he has an altogether new method of study. He may choose which method he pleases; the study is utterly unlike a series of tasks; he does not get to think of a duty as something disagreeable; and, above all, he is encouraged to think for himself. Instead of constant correction, criticism, and reproof or punishment because he will think for himself, he is encouraged to consider that opinions which he disagrees with are to be criticised by him. If he feels that it is quite hopeless for him to follow abstract reasoning, say about a whole being greater than its part or the ratio of two incommensurables, or justification by faith, we reply to him—Yes, my boy, you have a good healthy mind like 98 per cent. of

all English boys ; it is quite impossible for us to make a seventy-year-old Alexandrian philosopher of you, thank God ! time enough for you to do that for yourself when you have finished your educational course.

I say that this observational and experimental kind of study is almost the only one in which it is possible for a teacher to guide and instruct without doing harm—and it is very important that a boy's studies should be guided. Take the very clever boy who dislikes the study imposed upon him, and who takes earnestly to something else, his own choice, in which he has no guidance. See how he becomes a "crank." A man who might be of the salt of the earth if he could only co-ordinate his opinions with those of other people, a leader among men of thought ; he loves to differ from all other people, and wastes a valuable life in disputation.

I know that many readers will find it difficult to consider this question ; they will find it impossible to see things from a new point of view. As a rule a man has no point of view of his own, he never thinks for himself except about certain matters that only concern himself. Even a learned man thinks, not on the subject of his learning, but about his special methods of cataloguing his knowledge, and of course it is only from this that he can get any mental enjoyment. The dullest boy thinks a good deal, and even the average man, although thinking for himself has been repressed in him all his life. We ought to call all such people pedants, because they never really think about things of general interest to the world. It is extraordinary how general is the impression of everybody that he really does think for himself and comprehends what he says. At the age of fourteen I wrote an excellent little essay on Chaucer ; I recollect now that my knowledge of Chaucer was confined to a few of the well-known extracts.

The opinions of educated young men change with the moon, or rather with the period of publication of the monthly magazines. A mathematical teacher uses the same fallacious logic in some demonstration year after year, and at length finds out his mistake from somebody else. Learning seems to destroy all power to think. From 500 A.D. to 1453 A.D. the scholars of Constantinople, with all the learning of Greece and Rome, produced not one original work.

I think that for a very clever boy any subject of study is good enough, although not so good as natural science. But Sanscrit, Chinese, or any other language and literature, or astrology or divinity, is just as good a medium as Greek or Latin, if all the best men of his own time happen to use the same medium, and if it enables him to come into mental contact with great men. But what of the other 98 per cent. of all boys—the average boys ?

The men who frame schemes of education really frame them for boys such as they themselves were. Anybody who cannot follow such a scheme is said to be stupid, and he is so often called stupid that he actually gets to think himself stupid. In this nineteenth century we do not wish, as in the time of Erasmus, to produce merely a few learned men. At all events, if parents pay largely for education, we do not think it fair to send back 98 per cent. of their sons with the contract unfulfilled on our part. Think of 100 boys being sent to a bootmaker who had only one kind of ready-made boot of one size. He sends ninety-eight of the boys back with feet so hurt by trying on that they can never wear anything but slippers all their life after ; he keeps their money, and compels the boys and their parents to take all the discredit of the transaction. Christ's curse is on the schoolmaster when he calls a boy a blockhead.

It is a very curious thing that when a boy has been called a dunce a number of times he actually gets to think himself a dunce, and in after life never blames his schoolmaster ; he has only praise for the system

of education. Men who have never been able to do more than quote tags from the Latin grammar, or get beyond the Asses' Bridge in Euclid, are usually quite enthusiastic about the value of the orthodox education in the training of the mind, and so we find engineers and other illiterate persons advocating classical education. A donkey might just as well brag of the enormous advantage it was to him in having once been kept about a racing stable. But a much more curious thing is the praise given by clever mathematical physicists to the wretched system of teaching of Euclid which wasted their youth. A well-known and exceedingly able and ingenious scientific man praises the school teaching in physics and chemistry which he had as a boy from a certain master of his, and yet everybody who knew master and pupil knows that the pupil became a scientific man in *spite* of, and not through, the teaching of his master. Even if such clever men were right as to suitability of a system of training for themselves, they have no right to assume that it is right for the other 99 per cent. of boys at school.

Classical education gets all the credit that ought to belong to the other kinds of education that usually accompany it. A boy is at a good public school at which healthy, moral, manly training of all kinds is given to the usual manly type of boy. All the best masters are probably good in classics. The boy's own prizes are for classics, because there are not often scholastic prizes for anything else. Success in classics has been always put before him as the highest kind of success. The boys whom he worships are all good in classics. Of course, classics gets the credit for everything, including those things that are good in *spite* of the classics. Even good manners and tact and amiability, and I might almost say good batting and bowling and fielding, are thought to be due to the classics. The defenders of classics are numerous, and miss no chances. A scientific friend of mine, before a royal commission, commended the study of Greek, because the Greek alphabet is so much used in mathematics. Surely for such a purpose Chinese is ever so much more valuable, as there are many more letters. Again, it is said that the study of classics helps one greatly in the study of modern languages. These defenders forget that Russians and Japanese are the best of linguists, and yet they seldom learn any Latin or Greek. It is strange also to find so many English boys, trained for years in Latin and Greek, who seem to find insuperable difficulties in learning a modern language. In any case, I am inclined to think that there is too much inclination to force boys to learn modern languages. Some boys learn easily ; for them the study may be good. Others learn with extreme difficulty. Had they not better study something else ?

Everybody is aware of the enormous difficulty of introducing a new invention, however valuable, if it involves the "scrapping" of much existing machinery. Thus, electric methods of working the District Railway have not yet been introduced. The comfort of railway passengers everywhere is only slowly being attended to. For this reason electric lighting proceeded slowly in England and quickly in America.

Now all the machinery of a school head master is fitted for the teaching of Latin and Greek. Every master is able to teach Latin well to clever boys, and everything good for mental training for clever boys in such teaching is well known to him. These men with capital so invested look with alarm on every new footing gained by science in schools, and with a wisdom gained by experience they introduce what *they* call science teaching, adopting methods which are such as can only disgust boys and their parents with the new study, and then they point to their want of success as a proof that the study of science affords no good education.

The prospect is very dismal ; for the capitalists whom we fight against, whose interests we directly attack, are

not only some of the very cleverest men of the country, but they have the ears of nearly all the other clever men.

In the time of Henry VII. the new learning fought and conquered the schoolmen, and England soon became covered with good grammar schools. Then mathematics came gradually in, fighting a hard fight till it has made its way and established itself—not on equality terms, but on terms of sufferance and recognition. To meet modern wants, to equip our men for the fight of to-day, we find that it is absolutely necessary to introduce the study of physical science, and lo! we have opposing us the combined forces of classics and mathematics, each with its own kind of weapon. The weapon of the mathematical pedant is the more dangerous, for he says that he already represents science.

This teaching of pseudo-science in schools has created a manufacture of teachers. At all the universities we are now manufacturing science B.A.'s and B.Sc.'s because there is a new profession where money may be earned by the holder of such a title. This manufacture is called scientific education, and our real scientific men, pleased with the name, pleased at any experiment in scientific education, afraid that if they object there will be no education whatsoever in science, weakly give their countenance to it. To illustrate what I mean:—At the greatest of our universities there is an examination in which experimental physics plays an important part. A friend of mine coaches men for this examination. He tells them: "Listen to my coaching, read the books as I tell you, take care *not* to attend the physics laboratory. For in one day's reading you will get to know all that there is in thirty pages of the book; you may spend a month at the laboratory and you will have gained practically nothing to fit you for any possible kind of examination. The laboratory does not pay." Of course he is right, but if mere learning, if mere knowledge of certain facts, mere power to pass an examination, are what is aimed at, surely there is no scientific education here. My friend asserts that the system by which he earns his living is abominable. The whole thing is so wrong that one wants an earthquake or a fire, one prays for wholesale destruction of the easily working examination machinery.

I remember teaching physics at a school in which the time for science was so limited that only one half-hour's lecture per week could be given to the best men in the school. There were about 100 of them, from the sixth and fifth forms. Some of them are now leaders of English thought. Well, they were actually examined once a fortnight—a paper examination, lasting an hour. Of course, they were not examined on the two lectures; they were really examined on two chapters of the text-book. I am told, and I believe, that in many of the best girls' schools science is supposed to be taught by a teacher reading things from a text-book, the girls taking notes. I should think it an excellent system if girls are required to pass the usual examinations.

Examinations are said to be in mechanics or dynamics, or mathematical physics, or mechanical or civil engineering. They are not; they are fraudulent substitutions of the stupidest kind of mathematics for these sciences.

Assume something or other to be true, that the coefficient of friction is constant, for example, or that a specific heat is constant, and, after covering the paper with easy mathematical exercise work, arrive at mathematical expressions which are as worthless as the mental training is bad. What a wonderful and useful weapon one possesses in mathematics! In the hands of a man like Rankine, or Kelvin or Maxwell, it removes mountains of difficulty. What a stupefying and useless weapon it is in the hands of a skill-less person who cannot think! And our examination systems and methods of education seem framed to cultivate one Kelvin to 10,000 of the pedantic non-thinking users of mathematics.

My theme has been the necessity for a complete change in our system of early education of everybody. The necessity is specially great in the case of the captains of industry. Many people think that if men are to be taught the scientific principles underlying the proper conduct of business or manufacture, it is only necessary to establish Technical Schools for them. When I was young I remember that there were many agricultural colleges in Ireland; they have all but one been failures. Why? Because the entering pupils were not fit to receive instruction. Instead of their having been prepared for instruction by their earlier education, this had done as much as possible to unfit them. We have just this sort of experience in our Technical Colleges. Great boys enter them, and it is difficult to find out what are the scraps of Euclid and mechanics known to these boys on which one has a chance of building technical instruction. It would almost be better to send such boys direct into practical work; they would probably do as well as the average workman; their fathers' influence and money would get them superior positions, and in a country like England they would do as well as their competitors in business. Yet there can be no doubt that it is of the utmost importance to our country, if we are to retain our supremacy in manufactures, that all managers of works, and many of the superior persons employed in large works, should be scientific men, who are also well experienced in the applications of science to their particular industry. But this is not all. I have heard it said, quite truly, that for a great mechanical engineering works what is needed are well-trained managers and foremen, the best labour-saving tools, and an army of negroes as workmen. I am inclined to think that this statement is true; but there is something to be said for the employment of well-educated, intelligent workmen. First, because they are citizens of the country having votes; second, because I believe that all invention comes up from the common workman. These men make thousands of observations, which somehow get to their superiors, and it is through these that inventions come unconsciously; an inventor makes use of ideas received from hundreds of men; the invention is truly his own, but he receives suggestions, unconsciously, from the men who work with their hands at the bench and in the machine shop. If then, I am right, the manufacturing country that depends upon a few good managers and an army of unintelligent slaves will fall as the Roman Empire fell.

Now a workman's intelligence must come through his trade, else he cannot be happy; and if he is unhappy in his trade he cannot be a good citizen or an efficient workman (from the above point of view). At present we pitchfork many boys into a factory, and depend upon the good nature of the workmen for their learning their trade. It used to be that a master taught such a boy his trade as a member of his own family. This personal teaching is no longer possible; but nothing has taken its place. Attendance of apprentices at evening classes after a hard day's work is quite out of the question for all but a small number of very clever young martyrs who sacrifice, not merely their own health and comfort, but the comfort of their families and their duties as citizens. I have myself publicly suggested several times a remedy for this state of things, which has been praised by competent persons, but it seems to me that it is hopeless to expect any adequate remedy to be applied until the influential people of this country are made to see the gravity of the present position.

The great remedy for all our troubles lies in convincing all influential people in this country that we really must make great radical changes. I have known the subscribers of money to a large technical college in England (the members of its governing board) to laugh, every one of them, in private over the idea that such an institution could do any good to the trade of their town.

How could it possibly do any good when there was such a spirit of unbelief among such people? We must create in England what already exists in Germany and France, and to some extent in America—a belief in the importance of scientific training everywhere. At present there is utter unbelief, and it is due to a bad system of education, which keeps everybody out of sympathy with everything scientific. It is terrible to hear our designers of bridges and steam engines and dynamos and great engineering schemes laugh at science and calculation, especially when one knows that foreign engineers are sneering at our best men; but it is well to know that, in spite of their laughter, our engineers are doing their very best to make use of all the true science that they have ever learnt; it is like gold leaf—very thin, but it serves a useful purpose. What they see clearly is the uselessness to God or man of such a so-called scientific training as they themselves had; they do not dream that there is a real scientific training possible by which useful mathematical and other weapons for solving all sorts of practical problems, handy to use and always ready, may become part of the mental machinery of the average man.

Four hundred years ago, reading, writing and cyphering were taught badly, and practical men looked upon them as things good to forget, things good for priests. If a layman could read or write, he was probably a useless person who, because he could not do well otherwise, took to learning. What a man learnt was clumsily learnt; if he learnt much, he was fit for nothing but learning; usually he learnt little with great labour, and made no use of it; therefore reading, writing and cyphering seemed useless. Do they seem now so very useless; now that everybody can learn them fairly easily? It is not so easy now to say that a man is useless merely because he can read, write or cypher. When I was an apprentice, and no doubt it is much the same now, if an apprentice was a poor workman with his hands, he often took to some kind of study, which he called science. In fact, science got to be the sign of a bad workman. But if workmen were so taught at school that they all really knew a little science, science would no longer be laughed at. When a civil engineer or electrical engineer fails because he has no business habits, he takes to calculation and the reading of so-called scientific books, because it is very easy to get up a reputation for science. The man is a bad engineer in spite of his science, but people get to think that he is an unpractical engineer because of his scientific knowledge.

Germany has an enormous advantage just now in this, that all thinking Germans, all influential men, believe that their great success in commerce and manufacture has come through physical science. Every manager and foreman, every captain of any kind of industry in Germany and Switzerland, has passed with honour through the science classes of a great technical school. The money that used to flow towards religious institutions now finds its way towards the greater and greater development of scientific education, so that Germany is getting covered with universities of science.

The open-hearth process has enabled German ores of iron to be used in steel manufacture. The war-earthquakes have stirred up the German people to new life, have produced enthusiasm, and made all kinds of ambition respectable. Any one who knew such a tumble-down, poverty-stricken town as Hanover forty years ago would not recognise it now. There are miles of streets of the brightest shops in Europe; at any time of the day or night one can read a small print newspaper in these streets; the streets throng with traffic, and the electric tram-cars have extended the city far into the country; and so it is in hundreds of towns, and manufactures flourish in thousands of places where the hare and partridge used to have the scenery to themselves. I do not think that the progress of

Germany would have been half so rapid had it not been for the scientific education of the German leaders, but it is absurd to say that all this progress is due to science. The fact is that the whole world is developing its natural resources. England had the start; every country that has coal and iron, or their equivalents, is competing with England. The countries of greatest natural resources can afford to neglect their scientific education longer than others; but, sooner or later, knowledge and method and character must tell. If countries are equal in their natural advantages, victory must remain with that one in which there is the best education.

I have hitherto been reviling only the higher education in England. Until quite recently there was no primary education to revile. Let me put before my readers a true contrast. In Scotland, at any time during the last 100 years and more, if in the very poorest parish there was a boy of promise, a boy who showed a fondness for reading, for learning, for taking in what then and now goes under the name of education, a fondness for coming into contact with great minds through books—the success of that boy in life was absolutely sure. However poor his parents might be, however remote his humble home might be from civilisation, he was sent to the university, and got his chance. His nation gloried in his success, even if his own poor country had to be left by him for the richer field of England. Of all the great doctors and ministers and scholars of Scotch blood now to be found in London, only a very few can say that they were not exceedingly poor in their youth. Now contrast such a boy's chances with those of a clever English boy some years ago. Why, until the ever-to-be-praised Science and Art Department gave him a chance, a poor English boy, however promising, was compelled to eat his heart out in unavailing regret, was taught that it was a sin to think of bettering his condition, was taught that a decent education was as remote for him as for the cattle he tended.

I believe that this difference was due to the fact that in Scotland everybody thinks well of a good education, of knowledge, of mental power, because he himself can think, whereas in England education is looked upon with contempt, because there is not one labourer in a thousand who can think.

I do firmly believe that the Prince Consort saved this nation from utter defeat, and that if we are not yet to be defeated we must do as he would have continued to tell us to do. Had he lived till now, this country would not merely have the beginnings of a development of art and science; it would be covered with educational institutions whose most important object would be scientific study, a secondary leaning to literature not being neglected. As it is, we have the merest dust of his mind expanded into a wonderful Science and Art Department, which is criticised adversely only by the very ignorant or the very prejudiced. Only people like myself, whose whole life has been a pæan of gratitude for what that department has done for me and mine, who have seen in thousands of cases that it has redeemed otherwise wasted lives with enormous benefit to our industries, are really in a position to imagine how much that great man might have done for us if he had lived.

For one thing, just as the Science and Art Department is the envy and admiration of foreigners; just as it is an English institution, made to fit England and no other country, so he would have developed scientific education in England on lines utterly different from the soul-destroying system of Germany or its imitation in America.

Consider a scientific German as you know him. Say that he is twenty-three or twenty-five years of age, and he is about to enter business. From the age of seven or less he has trudged to school, perhaps at 7 o'clock in the morning, with a bag of books of half his own weight. He had a short interval for dinner, and went on to

6 o'clock at night. And he went on like that till now. There is no fact in all his school books that he has not heard a thousand times. He has had Goethe's maxims so drilled into him that he is "thorough" in every detail. I can imagine one Englishman in a hundred, after such a training, patiently turning over the muck heap of his knowledge; his eye would not gleam with any enthusiasm, but rather would glaze with envy and jealousy at the undeserved success of quite ignorant persons. And yet he would have knowledge, and know in his way how to use it; and it is because Germany has so many thousands of men trained in this way that she is certainly beating us to-day. They may be rather heavily loaded with learning, and I know that decently taught Englishmen who spent less than half the time at studies twenty times more interesting would beat them hollow in manufacture or research, would be the reverse of dull, and would be good citizens; yet the Englishmen I want only exist as yet by ones and twos, and such Germans are numerous. But just think of it! Here we are, a hard-headed, obstinate, cool race of men, who have had no end of chances in our safe little island, whilst our enemies were fighting among themselves, with coal and iron and the influx of good foreigners to set us first in the new field, and we have more than half of all the wealth of the world, and all that is needed for our keeping our good things is that we should believe them to be possibly evanescent; that there really is a chance that some better equipped nation may take them away from us, and therefore that we ought to prepare ourselves to fight for them. We have many chances in our favour and we hardly use them; the competing foreigner is very energetic, and cultivates his smallest chances.

JOHN PERRY.

HUMAN BABIES: WHAT THEY TEACH.

AN investigator anxious to obtain information as to the relationship of a particular species puts the question "What characters do the young stages exhibit?" and in order to answer that question he makes a study of the developmental phases exhibited by those stages. He may argue that if he finds certain characters in the young stages indicative of, and adapted to, habits of life which the adults do not possess, then there must have been a time in the ancestry of the species when such habits of life were of particular value, otherwise they would never have been developed. Or he may simply give, as the reason for his method of research, the concise statement "ontogeny repeats phylogeny," or he may hold to the theory of acceleration of development—which is more than a theory, because it is an actual fact of palæontology—that the characters of adult ancestors tend to become the characters of youthful descendants, thus producing specific diversity, without the necessity for a theory of natural, or any other form of selection, merely by inequality in the rates of developmental acceleration in different stocks. Wherefore *vice versa* the characters of youth must at one time have been adult characters; and their differences from those of the adult indicate the degree of different environment under which the adult ancestors lived.

The manner of expressing the reason for a method of research may vary; the method itself remains the same. To know the past history of an organism, study the young. That is a method of universal application. It is the guiding principle of all researches into the past history of organic beings. It becomes then equally applicable to man himself; and in that way the human baby becomes an object of scientific attention. To study the human baby in this manner, the aid of photography is important; it gives a permanent record of what would otherwise be forgotten.

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The early attempts of a baby in the matter of progression are particularly instructive. The bipedal gait is not attainable, indicating that the bipedal ability of the human being is of quite recent acquirement. What the child does show is either a truly quadrupedal method of progression, as in Fig. 1, which is also said to be common among children of uncivilised parents, or a kind of falsified quadrupedal progression on the hands and knees, which obtains generally among children of civilised parents, owing no doubt to impediments of clothes, and to over-coddling. Both methods of progression point to the same conclusion, though, of course, the former is the better illustration—that the ancestors of man were animals accustomed to a quadrupedal gait.

The influence of this quadrupedal gait of the ancestors is very strong. The child really has to unlearn it, and to readapt its hind limbs before it can attain the bipedal method of progression. The necessity for such readaptation, and the difficulty of acquiring the balance which progression on hind limbs demands, make the child's early efforts at walking so difficult. Observe a child just able to balance itself momentarily on its hind limbs. The insecurity of the position is shown by the attitude of the arms—outspread to help the balance, and by the feet being planted widely apart. The imperfection of the hind limbs for a bipedal gait is particularly noticeable.



FIG. 1.—Child ten months old, on garden path.

The legs are not straight, but they are considerably bent at the knee. That bending is incorrect for a bipedal gait; but it is a necessity of a quadrupedal progression, and it is just the feature seen when a four-footed animal, such as a cat, is induced to stand on its hind legs. In learning to walk on its hind legs the baby has to make many alterations in the anatomy of its hind limbs to fit them for their new function; and the human ancestors, in order to pass from quadrupeds to bipeds, must have had to do the same.

There is another feature noticeable in regard to such a child in its first attempts at walking—the semi-clasped position of the hands. That is natural, it may be said. Certainly it is, but nevertheless a natural feature requires an explanation, and may be of particular significance. Such is the case here; the semi-clasped position of the hands is naturally and instinctively assumed because the human ancestors had for so many generations been bough-grasping animals, quadrupeds who lived among trees, who particularly used their hands for grasping boughs. Had they used the hands in a manner which always produced extension, then the extended position of the fingers would have become habitual.

Further evidence of the particular character which generations of bough-grasping ancestors have given to the hands of children may be obtained in this way—Get